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White Paper

**VALIDATION OF THE NEUROZONE®
BRAIN PERFORMANCE DIAGNOSTIC**

JANUARY 2017

1. STUDY 1

1.1 Objectives

This study is aimed at psychometrically validating the Brain Performance Diagnostic (BPD).

1.2 Sample

Data was collected through online assessments over a period of five months. A total sample of n = 713 responses was collected. The mean age of participants is 37.05 (SD = 10.743) most of whom are female (55.0%).

1.3 Methodology

Maximum likelihood with oblique rotation via SPSS was used to conduct the Exploratory Factor Analysis (EFA). Factors that had an Eigenvalue > 1 was retained whilst factor loadings were considered sufficiently high if the loading was > .35 [1][2]. Internal consistencies for each subscale was considered satisfactory if α > .75 [3].

1.4. Results:

1.4.1 Foundational Scale

FOUNDATIONAL SCALE				
	EXERCISE	**NUTRITION**	**SLEEP/WAKE CYCLE**	**SILENCING THE MIND**
Exercise 1	0,814			
Exercise 2	0,873			
Exercise 3	0,727			
Exercise 4	-0,042			
Exercise 5	0,629			
Nutrition 1		0,062		
Nutrition 2		0,264		
Nutrition 3		0,141		
Nutrition 4		0,198		
Nutrition 5		0,307		
Nutrition 6		0,317		
Nutrition 7		-0,025		
Nutrition 8		-0,018		
Nutrition 9		0,451		
Nutrition 10		0,614		
Nutrition 11		0,284		
Nutrition 12		0,551		
Nutrition 13		0,555		
Nutrition 14		0,474		
Nutrition 15		-0,038		
Sleep/Wake Cycle 1			0,458	
Sleep/Wake Cycle 2			0,528	
Sleep/Wake Cycle 3			0,112	
Sleep/Wake Cycle 4			0,4	
Sleep/Wake Cycle 5			0,319	
Sleep/Wake Cycle 6			0,437	
Sleep/Wake Cycle 7			0,317	

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[1] Costello, A. B., & Osborne, J. W. (2011). Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. Pract Assess Res Eval 2005; 10. URL *http://pareonline. net/getvn. asp,10(7).*

[2] Floyd, F. J., & Widaman, K. F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological assessment*, 7(3), 286.

[3] Nunnally, J. C., & Bernstein, I. H. (1994). The assessment of reliability. *Psychometric theory*, 3(1), 248-292.

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FOUNDATIONAL SCALE (CONTINUED)				
	EXERCISE	NUTRITION	SLEEP/WAKE CYCLE	SILENCING THE MIND
Silencing the Mind 1				0,741
Silencing the Mind 2				0,733
Silencing the Mind 3				0,662
Silencing the Mind 4				0,633
Silencing the Mind 5				0,658
Silencing the Mind 6				0,745
Silencing the Mind 7				0,749

1.4.1.1 Exercise

The Exercise items explained 58.75% of the variance in Exercise (Eigenvalue = 2.585). Exercise 4 was removed due to an inadequate loading with the remaining items successfully loading (>.35) onto Exercise with a mean inter item correlation of .576. The internal consistency for the scale was found to be sufficiently high (α = .846).

1.4.1.2 Nutrition

The Nutrition items explained 12.18% of the variance in Nutrition (Eigenvalue = 2.738). Nutrition 1,2,3,4,5,6,7,8,11 and 15 was removed due to inadequate loadings with the remaining items successfully loading (>.35) onto Nutrition with a mean inter item correlation of .282. The internal consistency for the scale was found to be subpar (α = .662).

1.4.1.3 Sleep/Wake Cycle

The Sleep/Wake Cycle items explained 15.10% of the variance in Sleep/Wake Cycle (Eigenvalue = 1.87). Sleep/Wake Cycle 3,5 and 7 was removed due to inadequate loading with the remaining items successfully loading (>.35) onto Sleep/Wake Cycle with a mean inter item correlation of .201. The internal consistency for the scale was found to be subpar (α = .500).

1.4.1.4 Silencing the Mind

The Silencing the Mind items explained 49.64% of the variance in Silencing the Mind (Eigenvalue = 1.87). No items were removed due to inadequate loading with all the items successfully loading (>.35) onto Silencing the Mind with a mean inter item correlation of .495. The internal consistency for the scale was found to be excellent (α = .871).

1.4.2 Emotional Scale

EMOTIONAL SCALE			
	SOCIAL SAFETY	GOAL DIRECTEDNESS	COLLECTIVE CREATIVITY
Social Safety 1	0,462		
Social Safety 2	0,514		
Social Safety 3	0,593		
Social Safety 4	0,739		
Social Safety 5	0,702		
Social Safety 6	0,589		
Social Safety 7	0,701		
Social Safety 8	0,587		
Social Safety 9	0,526		
Social Safety 10	0,559		

EMOTIONAL SCALE (CONTINUED)			
	SOCIAL SAFETY	GOAL DIRECTEDNESS	COLLECTIVE CREATIVITY
Goal Directedness 1		0,233	
Goal Directedness 2		0,449	
Goal Directedness 3		0,597	
Goal Directedness 4		0,551	
Goal Directedness 5		0,473	
Goal Directedness 6		0,303	
Goal Directedness 7		0,512	
Goal Directedness 8		0,473	
Goal Directedness 9		0,532	
Goal Directedness 10		0,564	
Goal Directedness 11		0,603	
Goal Directedness 12		0,556	
Goal Directedness 13		0,528	
Goal Directedness 14		0,494	
Goal Directedness 15		0,556	
Goal Directedness 16		0,503	
Collective Creativity 1			0,304
Collective Creativity 2			0,36
Collective Creativity 3			0,442
Collective Creativity 4			0,552
Collective Creativity 5			0,645
Collective Creativity 6			0,674
Collective Creativity 7			0,273
Collective Creativity 8			0,277
Collective Creativity 9			0,556
Collective Creativity 10			0,319

1.4.2.1 Social Safety
The Social Safety items explained 36.65% of the variance in Social Safety (Eigenvalue = 4.27). No items were removed due to inadequate loading with all the items successfully loading (>.35) onto Social Safety with a mean inter item correlation of .359. The internal consistency for the scale was found to be excellent (α = .849).

1.4.2.2 Goal Directedness
The Goal Directedness items explained 25.47% of the variance in Goal Directedness (Eigenvalue = 4.797). Goal Directedness 1 and 6 was removed due to inadequate loading with all the remaining items successfully loading (>.35) onto Goal Directedness with a mean inter item correlation of .278. The internal consistency for the scale was found to be excellent (α = .835).

1.4.2.3 Collective Creativity
The Collective Creativity items explained 21.56% of the variance in Collective Creativity (Eigenvalue = 2.869). Collective Creativity 1,7,8 and 10 was removed due to inadequate loading with all the remaining items successfully loading (>.35) onto Collective Creativity with a mean inter item correlation of .288. The internal consistency for the scale was found to be subpar (α = .689).

1.4.3 Higher Order Scale

HIGHER ORDER SCALE			
	LEARNING	**ABSTRACTION**	**EXECUTIVE FUNCTION**
Learning 1	0,108		
Learning 2	0,365		
Learning 3	0,407		
Learning 4	0,541		
Learning 5	0,624		
Learning 6	0,301		
Learning 7	0,11		
Learning 8	0,229		
Learning 9	0,144		
Learning 10	0,536		
Learning 11	0,372		
Learning 12	0,214		
Learning 13	0,006		
Learning 14	0,43		
Learning 15	0,372		
Abstraction 1		0,426	
Abstraction 2		0,118	
Abstraction 3		0,145	
Abstraction 4		0,518	
Abstraction 5		0,574	
Abstraction 6		0,628	
Abstraction 7		0,689	
Abstraction 8		0,503	
Abstraction 9		0,449	
Abstraction 10		0,464	
Abstraction 11		0,326	
Abstraction 12		0,395	
Abstraction 13		0,289	
Executive Function 1			0,643
Executive Function 2			0,783
Executive Function 3			0,754
Executive Function 4			0,297
Executive Function 5			0,285
Executive Function 6			0,114
Executive Function 7			0,249

1.4.3.1 Learning

The Learning items explained 13.10% of the variance in Learning (Eigenvalue = 2.748). Learning 1,6,7,8,12 and 13 was removed due to inadequate loading with all the remaining items successfully loading (>.35) onto Learning with a mean inter item correlation of .180. The internal consistency for the scale was found to be subpar (α = .664).

1.4.3.2 Abstraction

The Abstraction items explained 20.75% of the variance in Abstraction (Eigenvalue = 3.414). Abstraction 2,3,11 and 13 was removed due to inadequate loading with all the remaining items successfully loading (>.35) onto Abstraction with a mean inter item correlation of .266. The internal consistency for the scale was found to be satisfactory (α = .765).

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1.4.3.3 Executive Function

The Executive Function items explained 26.26% of the variance in Executive Function (Eigenvalue = 2.393). Executive Function 4,5,6 and 7 was removed due to inadequate loading with all the remaining items successfully loading (>.35) onto Executive Function with a mean inter item correlation of .529. The internal consistency for the scale was found to be satisfactory (α = .771).

1.4.4 Condition Scale

CONDITION SCALE				
	LEARNING CAPACITY	**RESILIENCE**	**INNOVATION CAPACITY**	**SELF-LEADERSHIP**
Learning Capacity 1	0,829			
Learning Capacity 2	0,797			
Learning Capacity 3	0,683			
Resilience 1		0,556		
Resilience 2		0,814		
Resilience 3		0,762		
Innovation 1			0,6	
Innovation 2			0,662	
Innovation 3			0,651	
Self Leadership 1				0,441
Self Leadership 2				0,757
Self Leadership 3				0,46

1.4.4.1 Learning Capacity

The Learning Capacity items explained 59.57% of the variance in Learning Capacity (Eigenvalue = 2.181). No items were removed due to inadequate loadings with all the items successfully loaded (>.35) onto Learning Capacity with a mean inter item correlation of .590. The internal consistency for the scale was found to be good (α = .812).

1.4.4.2 Resilience

The Resilience items explained 51.72% of the variance in Resilience (Eigenvalue = 2.003). No items were removed due to inadequate loadings with all the items successfully loaded (>.35) onto Resilience with a mean inter item correlation of .50. The internal consistency for the scale was found to be good (α = .75).

1.4.4.3 Innovation Capacity

The Innovation Capacity items explained 40.76% of the variance in Innovation Capacity (Eigenvalue = 1.594). No items were removed due to inadequate loadings with all the items successfully loaded (>.35) onto Innovation Capacity with a mean inter item correlation of .406. The internal consistency for the scale was found to be subpar (α = .67).

1.4.4.4 Self-Leadership

The Self-Leadership items explained 32.64% of the variance in Self-Leadership (Eigenvalue = 1.813). No items were removed due to inadequate loadings with all the items successfully loaded (>.35) onto Self-Leadership with a mean inter item correlation of .295. The internal consistency for the scale was found to be subpar (α = .56).

2. STUDY 2

2.1 Objectives

This study is aimed at confirming the factor structure of the instrument while further validating the measure.

2.2 Sample

An additional sample was collected over a three-month period via online assessments. A total sample of n = 898 responses was collected. The mean age of participants is 32.423 (SD = 14.080) most of whom are male (52.2%).

2.3 Methodology

Confirmatory Factor Analysis via LISREL was used to affirm the various factor structures uncovered by the EFA. The indices that was considered together with the acceptable standards was as follows [4] [5]:

- Chi Square/df ratio (>3)
- Comparative Fit Index (>.9)
- Incremental Fit Index (>.9)
- Root Mean Square Error of Approximation (<.08)

2.4. Results

2.4.1 Foundational Scale

The goodness of fit statistics indicate that the four-factor foundational model shows good fit and comfortably meets the criteria set out above. The fitted measurement model is shown in the figure below.

df=164, P-value=0.00000, RMSEA=0.053

TABLE 2 **GOODNESS OF FIT STATISTICS**					
χ^2	df	χ^2/df	CFI	IFI	RMSEA
625.77	164	3.82	0.96	0.96	.053

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[4] Byrne, B. M. (2001). Structural equation modelling with AMOS, EQS, and LISREL: Comparative approaches to testing for the factorial validity of a measuring instrument. International journal of testing, 1(1), 55-86.

[5] Kline, R. B. (1998). Principles and practice of structural equation modelling. New York: Guilford Press.

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2.4.2 Emotional Scale

The goodness of fit statistics indicate that the three-factor emotional model shows good fit and comfortably meets the criteria set out above. The fitted measurement model is shown in the figure below.
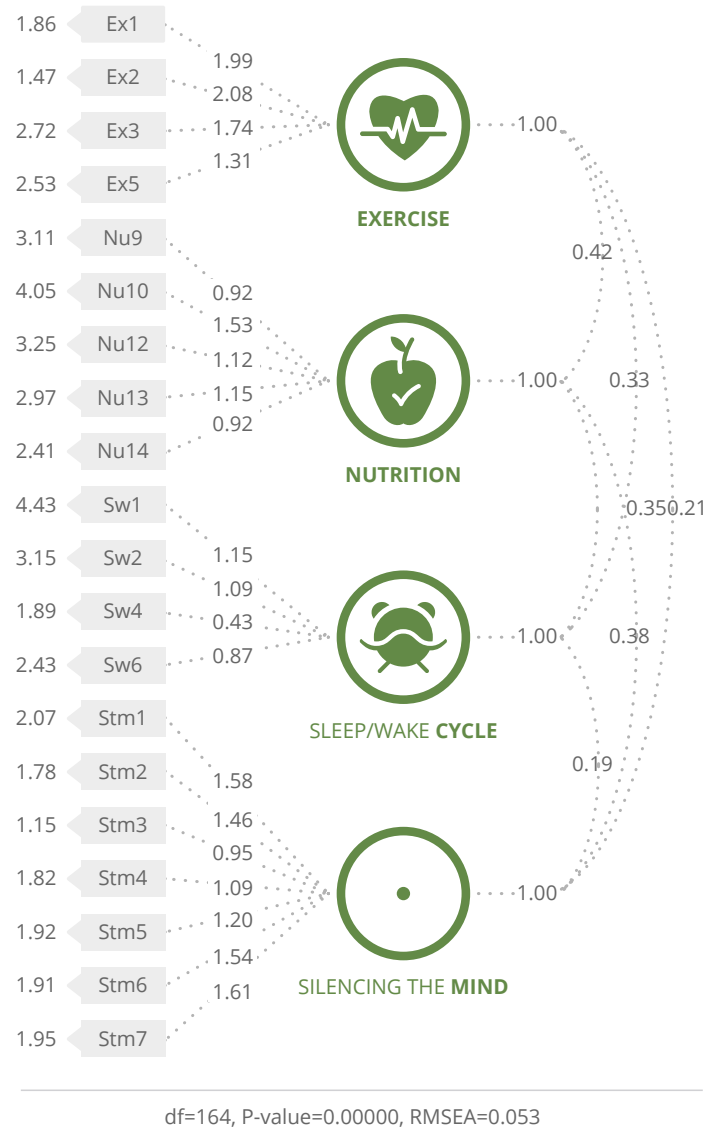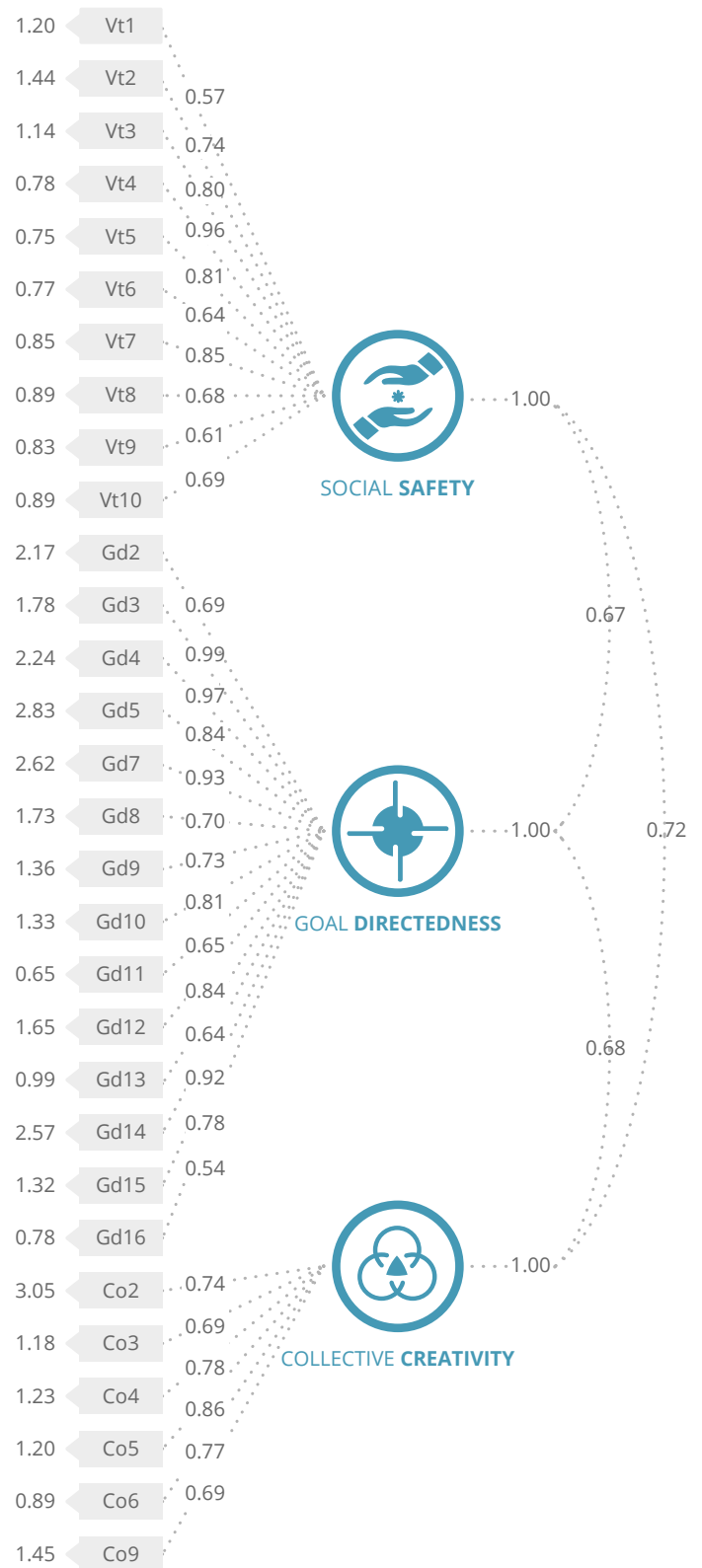
TABLE 2 GOODNESS OF FIT STATISTICS

χ²	df	χ²/df	CFI	IFI	RMSEA
2965.75	402	7.38	0.95	0.95	.058

1.20	Vt1
1.44	Vt2
1.14	Vt3
0.78	Vt4
0.75	Vt5
0.77	Vt6
0.85	Vt7
0.89	Vt8
0.83	Vt9
0.89	Vt10

0.57
0.74
0.80
0.96
0.81
0.64
0.85
0.68
0.61
0.69

SOCIAL SAFETY — 1.00

2.17	Gd2
1.78	Gd3
2.24	Gd4
2.83	Gd5
2.62	Gd7
1.73	Gd8
1.36	Gd9
1.33	Gd10
0.65	Gd11
1.65	Gd12
0.99	Gd13
2.57	Gd14
1.32	Gd15
0.78	Gd16

0.69
0.99
0.97
0.84
0.93
0.70
0.73
0.81
0.65
0.84
0.64
0.92
0.78
0.54

GOAL DIRECTEDNESS — 1.00

3.05	Co2
1.18	Co3
1.23	Co4
1.20	Co5
0.89	Co6
1.45	Co9

0.74
0.69
0.78
0.86
0.77
0.69

COLLECTIVE CREATIVITY — 1.00

0.67
0.72
0.68

47, df=402, P-value=0.00000, RMSEA=0.058

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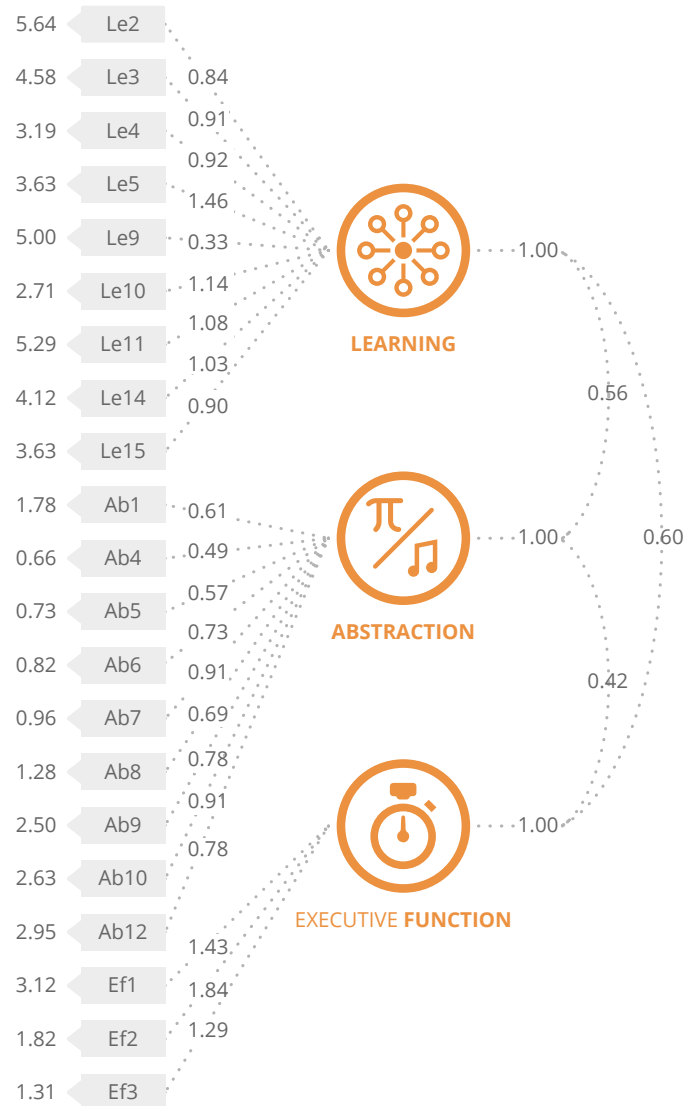### 2.4.3 Higher Order Scale

The goodness of fit statistics indicate that the three-factor higher order model shows good fit and comfortably meets the criteria set out above. The fitted measurement model is shown in the figure below.

TABLE 2 **GOODNESS OF FIT STATISTICS**					
χ^2	df	χ^2/df	CFI	IFI	RMSEA
698.17	186	3.75	0.94	0.94	.053

5.64	Le2
4.58	Le3
3.19	Le4
3.63	Le5
5.00	Le9
2.71	Le10
5.29	Le11
4.12	Le14
3.63	Le15
1.78	Ab1
0.66	Ab4
0.73	Ab5
0.82	Ab6
0.96	Ab7
1.28	Ab8
2.50	Ab9
2.63	Ab10
2.95	Ab12
3.12	Ef1
1.82	Ef2
1.31	Ef3

LEARNING — 0.84, 0.91, 0.92, 1.46, 0.33, 1.14, 1.08, 1.03, 0.90 — 1.00

ABSTRACTION — 0.61, 0.49, 0.57, 0.73, 0.91, 0.69, 0.78, 0.91, 0.78 — 1.00

EXECUTIVE FUNCTION — 1.43, 1.84, 1.29 — 1.00

0.56, 0.60, 0.42

Chi-Square=698.17, df=186, P-value=0.00000, RMSEA=0.053

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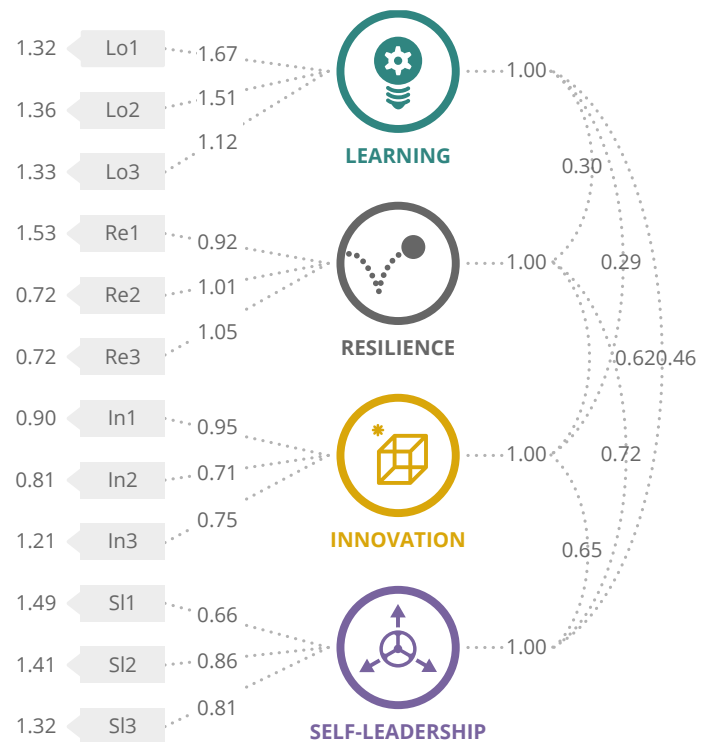### 2.4.4 Outcome Scale

The goodness of fit statistics indicate that the four-factor model shows good fit and comfortably meets the criteria set out above (except for the χ^2/df ratio). The fitted measurement model is shown in the figure below.

TABLE 2 **GOODNESS OF FIT STATISTICS**					
χ^2	d*f*	χ^2/d*f*	CFI	IFI	RMSEA
122.13	48	2.54	0.99	0.99	0.4

Chi-Square=122.13, df=48, P-value=0.00000, RMSEA=0.04   0

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